during the night. This increase must have been due to absorption of water by the leaves.

At 8.40 A.M. the bell-jar was removed to a window space and the damp atmosphere was obtained within the jar as before. The leaves of the plant were then thoroughly sprayed again and the plant was placed under the jar and left there in a strong light during the day. From time to time, as the water began to disappear from the leaves, they were resprayed. At 4 P.M. the plant was removed from the moist chamber and carefully dried. It was then weighed and showed a loss in weight since 8.40 A M. of 0.41 grams.

On repeating the experiment with the same plant, the increase in weight was 0.04 grams during the night—from 6.15 P.M to 8.20 A.M. From 8.20 A.M. until 2.30 P.M., there was a decrease in weight (transpiration) of 0.23 grams.

But was the increase in weight during the night in these experiments really due to absorption of water by the leaves? May not the moist air surrounding the plant have passed through the rubber covering and deposited some of its moisture upon the earth or pot, thus giving absorption by the earth rather than by the leaves? Such an interpretation of the experiment is forbidden by the condition of the interior found upon opening the rubber covering at the close of the confirmatory experiment. (That condition was not *precisely* known while the experiments described were in progress, for the plant had been subjected to experiments for several weeks, during which time its growth had made it difficult to give to the plant amounts of water exactly equal to the amounts transpired from day to day). Upon opening the rubber covering, the earth in the pot was found wet to the touch, the pot was wet, and the whole inner surface of the rubber covering was wet. In this condition of things, the greater movement of the water must have been from within the pot *outward* through the rubber to its dry outer surface and the drier—comparatively drier—air surrounding it in the moist chamber. If such a movement of water did occur, its effect was that of diminishing the weight of the plant during the night. We must regard absorption by the leaves as the cause of the increase which really occurred.

How potent a factor light is upon the functions of the plant, is readily seen by a comparison of the changes in weight during the day in these experiments with the changes during the night. At night, in the darkness, absorption perceptible by the balance occurred; during the day, transpiration predominated although the leaves of the plant were kept wet with water and in a moist atmosphere. Is it not possible that some of the failures to find absorption by leaves may have come through nice quantitative experiments having been carried on in the daytime, as would be the more convenient?

In conclusion, the experiments so far as they have been carried, seem to show—

(*a*) That leaves may absorb water.

(*b*) That leaves of growing plants do absorb water during the night when they are wet with water and in a moist atmosphere —i.e., under dew conditions.

INDIVIDUAL SKELETAL VARIATION.

BY FREDERIC A. LUCAS, U. S. NATIONAL MUSEUM, WASHINGTON, D. C.

THE subject of individual skeletal variation is one of considerable interest, to the morphologist from the hints it may give concerning lines of descent, to the systematic zoölogist from its bearing on the specific units of classification and to the vertebrate paleontologist since he must mainly rely upon more or less fragmentary skeletons for the determination of species.

External variations are readily perceived, often easily accounted for by known conditions of environment, but the question how much may the skeleton of a given species normally vary is by no means easy to answer.

Unfortunately the problem is rendered all the more difficult from the fact that the large series of specimens necessary for its solution are seldom available, so that characters may be considered of specific value, or, on the other hand, as mere abnormalities, when they are really normal variations or, perhaps, due to changes brought about by age. The following notes are somewhat desultory in their character, but they are based on the observation of considerable series of individuals of the various species referred to, and are brought forward as suggesting the existence of a large amount of individual skeletal variation.

In the report of the U. S. National Museum for 1887–88, the writer gave at some length the results of the examination of a large series of bones of the Great Auk, a series that was particularly interesting from the fact that it represented adult individuals from one locality and one epoch, so that any variations might be considered normal, and not due to differences of environment, or to modifications that might gradually come about in the course of time, even were there no change in surrounding conditions.

It may be briefly said that the long bones were found to vary to the extent of one-fifth of their length, but that the most interesting variations in the skeleton were the tendency to develop a ninth, extra pair of ribs and the frequent presence of a small tubercle on the tarsus, just where a hind toe would be located.

Very nearly one sacrum out of every seven possessed facets, showing the former presence of an abnormal number of ribs, while but one twelfth of the tarsi showed the little tubercle referred to.

Professor Newton found almost equally great variability in the bones of the Dodo and Solitaire, birds of unusually restricted habitat, but this he ascribes very largely to the fact that the remains examined probably represented individuals from very different epochs.

Among mammals the Orang seems to exhibit an unusual tendency to variation, and a series of crania of this animal shows many individual peculiarities.

Doubtless these are shown by other portions of the skeleton as well, but, at the time a large series of Orangs was available, my attention was directed almost entirely to the skull, and it can only be said that this species has considerable range in point of size, adult males being from four feet to four feet eight inches in height.

The Orang is a striking example of the cranial changes brought about by age, these being so great that four species have been founded on characters which a sufficient number of specimens shows to be due to age alone.

Apart from these it may be said that the foramen magnum has hardly the same shape in any two skulls, while the nasals vary as much, being sometimes long and narrow, sometimes short and broad, and in one case quite absent.

The shape and size of the orbits is very variable and they may be close together or some little distance apart. At the same time the supra-orbital ridges are often larger in rather young Orangs than in very old individuals.

A rather curious feature in the Orang is the tendency to develop an extra molar, the normal number being three, as in man. Usually this additional tooth is in the lower jaw and unpaired, but one jaw possessed four perfect molars on either side.

Our Mule Deer shows great cranial variability, both in size and proportions, and while typical skulls of the Mule Deer, the Columbia Deer, and Virginia Deer may be recognized at a glance, in many instances, where the antlers have been shed it requires careful examination to distinguish the skulls of the species apart.

The tendency to develop an extra pair of ribs is not very uncommon among birds, and, as we know, is occassionally seen in mammals, where it may take the form of a short pair of ribs on what would normally be the first lumbar, much more rarely a rib, or pair of ribs, on the seventh cervical, and sometimes that of an unpaired rib on the first lumbar.

In cases of this last mentioned variant the odd rib is usually longer than when an extra pair of ribs is present.

The true sacrals of birds are ordinarily devoid of parapophyses, in fact this is one of their distinguishing characteristics, yet among Cormorants these processes are not infrequently present and I have once observed them in a Goatsucker.

Although it is not uncommon to meet with an additional pair of ribs among birds, any lessening of the normal number is very rare and only once has such a case come under my notice, this

being a common Cat Bird in which the haemapophysis had disappeared from the first dorsal rib, the true ribs being thus reduced to five in number.

It is quite possible that reduction in the dorsal region has been carried almost to its utmost extent among birds and existing facts seem to support this theory.

Among the highly specialized Passeres, the normal number of ribs, counting as the first the most anterior that is connected with the sternum, is uniformly six.

Close to the Passeres stands the heterogeneous group of birds termed Picariæ, many of which are doubtless survivals of the ancient forms from which the Passeres have been derived.

If this be the case the line of descent of these Picarians is a long one and in many respects they may have undergone more modification than their more recent relatives.

Certain it is that in this group we find, with very few exceptions, those birds having the smallest number of ribs, sometimes only five pairs, and at least once, in our Night Hawk, only four.

In the Swifts, near relatives of the Goatsuckers, it is not asserting too much to say that we can actually see the process of rib reduction going forward, for among these birds we find many specimens with six pairs of ribs, rarely one with seven, and in the majority of cases six complete pairs of ribs and the lower portion of a seventh, and this lower rudiment is present in varying proportions.

Lower in the scale, among the Amphibians, the number of vertebræ is inconstant, even in such species as *Necturus* and *Menopoma*, whose pre-sarial vertebræ are fewer in number than in any mammal.

Necturus may have eighteen or nineteen pre-sacrals, *Menopoma* nineteen or twenty, *Siren* forty-one, forty-two or forty-three, and *Amphiuma* sixty-four or sixty-five.

Variation in the number of caudals is, of course, to be expected, but in the long-bodied *Siren* and *Amphiuma* it may amount to as many as five or six vertebræ.

A curious variant has been noted in the sacrum of *Menopoma*, which Huxley, in the last edition of the Encyclopædia Britannica, describes and figures as composed of two vertebræ.

Unfortunately the specimen on which the figure and description are based was abnormal, for, like the Salamanders, *Menopoma* has normally but one sacral, and an intermediate condition, a *true* abnormality, may exist of ten vertebræ connected with the ilium on one side and one on the other.

It is evident from the instances just related that a considerable amount of individual variation in size, proportion of various bones, or even in the presence of certain bones, may exist in a given species.

Differences of size, unless excessive, are of little value, provided the parts retain their relative proportions and in judging of differences of proportion the question of age must be taken into account also.

Broadly speaking, variations are of two kinds, due to modifications of development or of structure, and the importance of any departure from a given type depends very largely on the answer to the question, to which of these two categories does the variation belong.

Modifications of development produce individual variations of size and strength, length of limb and power of jaw, modifications of structure—when *constant*—give rise to specific, generic or ordinal distinctions, as the case may be.

In the occasional extra molar of the Orang the extra ribs of birds, the tarsal tubercle of the Great Auk, and the varying number of vertibræ in Amphibians we have variations of structure that, being inconstant, have no specific value, and yet have a morphologic meaning of their own.

The extra molar of the Orang is probably a reversionary character, the extra ribs of the Auk and the little nodule occupying the place of the missing metatarsal certainly indicate an ancestral form with a longer body and four toes.

In the abnormal sacrum of the *Menopoma* and the five pairs of ribs of the Cat Bird we have progressive variations, and these are of much rarer occurrance than retrogressive characters.

The parapophyses in the sacral vertebræ of Cormorants are teleological modifications, efforts to provide an additional brace for the pelvic walls of these strong swimmers.

The differences in the axial skeleton of birds and Amphibians indicate that variation in this region is not greatest in animals now possessing the largest number of vertebral segments, but in those whose embryology hints at the existence of more vertebræ in their comparatively immediate ancestors than are possessed by the descendants of these forms.

This would account for the frequent appearance of extra ribs in birds, the inconstancy of the number of vertebral segments in Urodele Amphibians, and the constancy in the vertebral column of mammals.

To conclude, many variations are reversionary in character, some progressive, and some due to physiological causes, most, if not all, have some definite meaning in their abnormality.

NOTES ON JAPANESE METEOROLOGY.

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DESPITE the humid climate of Japan, rheumatism is very rare among the natives, which is probably due to the practice of daily hot bathing.

The meteorology of Japan is exceedingly peculiar and of exceptional interest. As particular influences in the process of acclimatization may be mentioned, lessened, eliminatory activity of the lungs, increased activity of the skin, diminished cardial circulatory power. A prolonged residence in the Japanese climate is productive of general physical relaxation, with increased susceptibility to cold. After a two years' residence in Japan, Europeans feel the necessity of wearing more substantial winter clothing, as the climate seems to have become harsher since the beginning of their sojourn. Any foreigner who permanently resides there and wishes to feel at ease must resort to the hot bathing of the natives; being in Japan, he must do as Japanese do. Europeans, on their first arrival, are very prone to rheumatism, and even perfected acclimatization does not do away with that propensity. The hot-bath habit is singularly favorable to perfect acclimatization; it, and also the customary and frequent hot tea, mitigates the depressive influence of the summer kakké months, the wet season of June, July, and August. Strange to say, in their national disease, beriberi, there is an entire absence of perspiration; these patients perspire only in their last agony. One should think, after that, that the Japanese would consider baths as remedial in kakké. Strange to say, it is not so; they consider it only as an essential and, for them, very pleasant part of the toilet.

In kakké the popular verdict is, and has always been, that it is detrimental. The altitudinal is their most efficient treatment. Such a treatment is always, at least in our European and American experience, a dry one; dry air. It is not so in Japan; in their mountains, even as high as 3,000 feet above the sea level, you will find an increase of humidity, due to the precipitation from the volcanic peaks. Even in this heavy humidity, where they are endeavoring to cure a disease in which perspiration is suppressed, they do not give to the hot baths which are used there as much, but not more than in other not sanitary places, credit for any good accruing to the patients. And, in fact, if hot bathing contributed to the cure, such an influence would be observed at the sea-level as well as in high altitudes.

Of course, I cannot treat the question expressed here. Let me only say that, in my opinion, humidity has nothing to do, directly at least, with beriberi; it is not a climatic rheumatism. Its cause is the action of a carbonic poison in the blood, and that poison cannot be eliminated through the influence of hot water. Hot bathing, as I said, has nothing to do with it, either directly or indirectly. Indirectly humidity has, because it keeps the carbonic gases together and prevents their dispersion. The oxydizing influence of the pure air of the mountain heights has everything to do with the cure.